OPET CHP/DH WP 4

Informative measures on EU CHP directive and general dissemination of CHP/DHC

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Potential study of CHP - possibilities in Slovakia

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TITLE

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Table of contents

1. HISTORY OF COMBINED PRODUCTION OF HEAT AND POWER IN THE SLOVAK REPUBLIC

Combined production of heat and power in the steam cycle (conventional technology) was first developed in parallel with industrial expansion during the 1960s and 70s. Cogeneration technologies based on combustion engines evolved in the early 90s. Probably the first cogeneration unit was implemented in the locality of Dolný Hričov, near Žilina (year 1992). Two years later a cogeneration unit was installed at a swimming pool in Drienica (year 1994). A significant project involving the exploitation of biogas was carried out at an agricultural/animal farm in Bátka.

Historically, combined heat and power production was predominately provided in conventional heat and power plants, mostly in industrial facilities. Along with the development of industry, a housing infrastructure was built, creating the conditions for centralised heat supply. Small scale CHP units began to be used in the early 90s. These projects were oriented to centralised heating of houses, hospitals, swimming pools, and to utilisation of biogas created by methanegeneous processes.

2. PRESENT SITUATION

Because of the lack of specific and exact description of combined heat and power in Slovakia, cogeneration is divided into three groups in this Study:

- gas-engine small and medium cogeneration units (up to 5 MW_e)
- heat power plants
- gas – steam cycles

2.1. Small and medium cogeneration units (up to 5 MWe)

121 gas-engine cogeneration units are currently in operation in Slovakia. The total installed capacity is 16.3 MW_e and approximately 24.5 MW_t. Table 1 presents the number of units in operation and installed capacity of the sectors of implementation.

Sector of implementation	Number of units	Installed power capacity (kW_e)	Installed thermal capacity (kW_t)
Hospitals	24	2 423	3634.5
Food industry	3	416	624.0
Sewage tanks	13	1 033	1549.5
Agriculture	4	436	654.0
Communal sector	21	6 904	10 356
Administration buildings	7	2 297	3445.5
Hotels	16	465	697.5
Swimming pools	8	294	441.0
Industry	17	1 872	2 808.0
Family houses and others	8	164	246.0
Total	121	16 304	24 456.0

Table 1 Number and installed capacity of small and medium cogeneration units (up to 5 MW_e)

Figure 1 illustrates the number of cogeneration units according to the sector of operation (in Nové Zámky, one new CHP unit with installed capacity of 5.4 MW_e will be added in September 2002). Figure 2 shows installed power capacity of cogeneration units according to the sector of implementation. The biggest groups of units are in operation in hospitals and in the municipal sector, their shares are 19.8 % and 17.3% respectively. Following sectors of implementation are: industry, hotels and sewage tanks. Less than 10 units are installed in swimming pools, administration buildings, agriculture and the food industry. The shares were defined according to the number of units. In case we have to show the structure of installed capacity, the biggest share belongs to municipal sector - 42.35 % and hospitals are in second place – 14.9%.

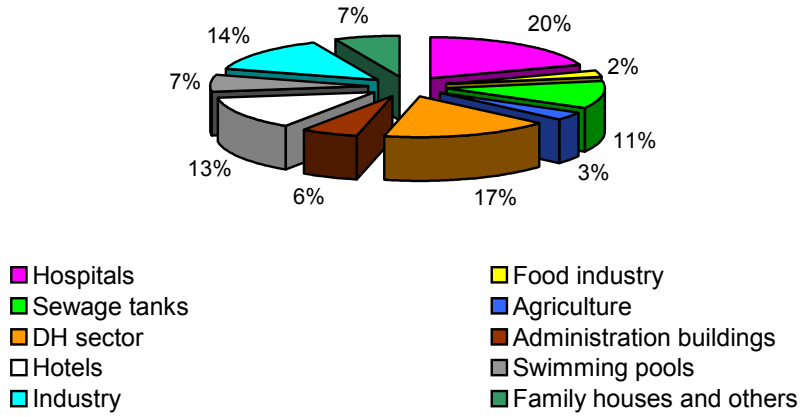

Figure 1 Number of cogeneration units according to the sector of operation

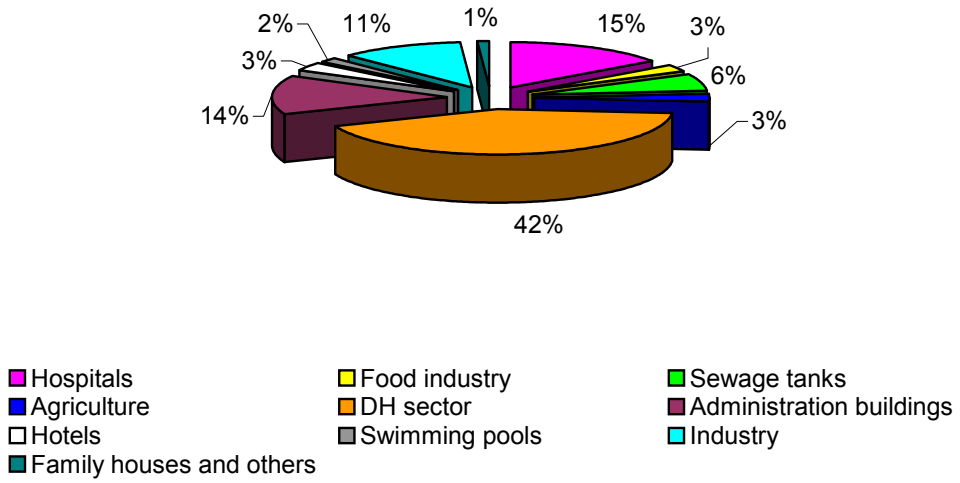

Figure 2 Share of installed power capacities of cogeneration units according to the sector of implementation (kW_e)

Four types of fuel are used in cogeneration units in Slovakia: natural gas, propane – butane, geothermal gas and biogas. The biggest share belongs to natural gas - 82.6 %, the share of other fuels is: propane – butane 2.5%, geothermal gas 0.8% and finally, biogas 14.1%. The shares were defined according to the number of units in operation. Table 2 presents the number of cogeneration units according to fuel type.

Type of fuel	Number of units	Installed capacity (kW_e)
Biogas	17	1 469
Geothermal gas	1	22
Propane – butane	3	53
Natural gas	100	14 760

Table 2 Number of cogeneration units and installed capacity according to fuel type

Figures 3 and 4 present the number of cogeneration units in operation and their installed capacity according to the type of fuel.

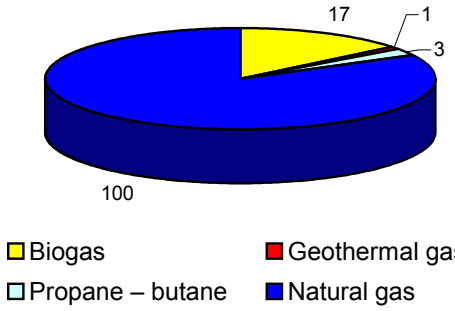

Figure 3 Number of cogeneration units (to 5 MW) according to the type of fuel

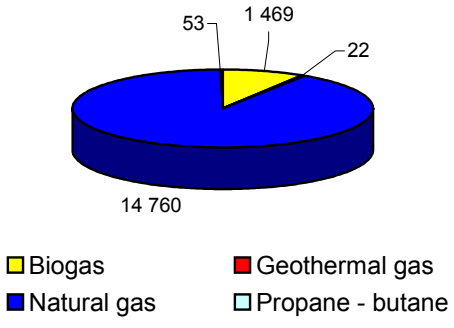

Figure 4 Installed capacity of cogeneration units (to 5 MW) according to the type of fuel (kW_e)

2.2 Heat and power plants

2.2.1 Conventional heat and power plants in the industry sector

Currently heat and power plants exist in 38 industrial companies. The biggest share of installed thermal capacity is 19.7% in the metallurgical industry, followed by chemical (18.5%) and malt & paper industry (16.4%). Electricity production in heating power plants is very low in comparison with thermal production. The ratio of thermal to electrical production is 10.7:1. Table 3 presents the number and installed capacity of heat and power plants according to the sector of industry.

Sector of industry	Number of boilers	Installed thermal capacity (MW_t)	Installed power capacity (MW_e)
Petrochemical	13	1050.0	114.0
Chemical	36	1536.1	141.8
Rubber industry	10	279.1	9.8
Malt & paper	24	1359.6	127.3
Wood industry	8	156.8	5.9
Textile	37	755.8	38.3
Leather industry	11	254.5	13.1
Metallurgical industry	20	1633.9	227.9
Mechanical industry	25	625.8	42.4
Food industry	15	646.8	56.4
TOTAL	199	8 298.5	776.6

Table 3 Number and installed capacity of conventional heating power plants according to the industry sector

Figures 5 and 6 present the number of conventional heat and power plants and their installed thermal capacity according to industry sector.

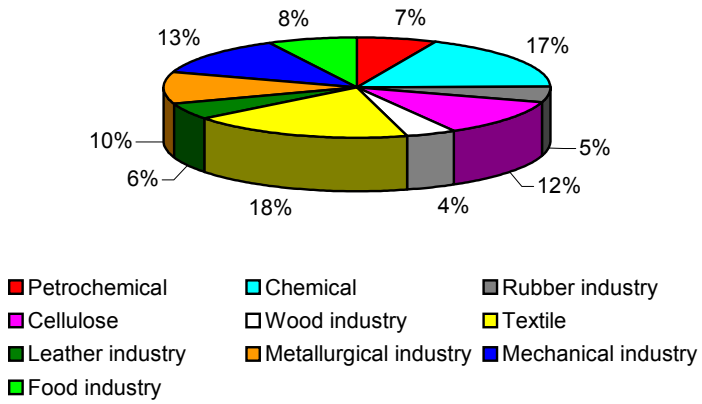

Figure 5 Number of conventional heat and power boilers according to industry sector

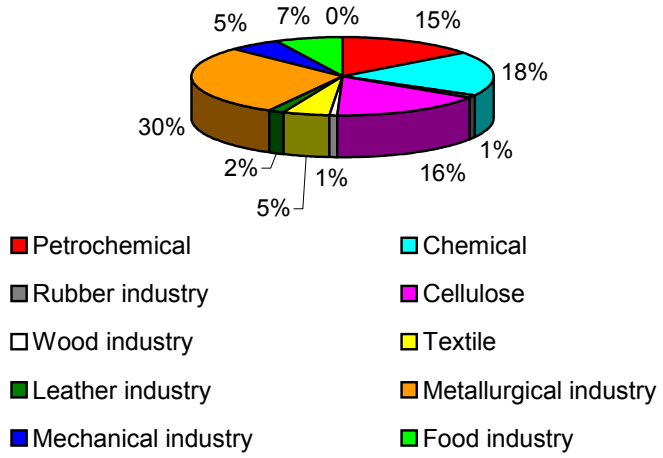

Figure 6 Installed power capacities of conventional heat and power boilers according to the industry sector (MW_e)

2.2.2 Municipal heat and power plants

There are 11 large-scale heat power plants currently in operation in Slovakia. Table 4 shows the structure and installed heat and power capacity. All heat power plants have a large installed capacity. They supply the power grid with electricity, and industry and municipal with heat. The heat power plant in Banská Bystrica was a conventional thermal plant before reconstruction. After a complete change of heat boilers and equipment, the company which owns this plant (1. Banskobystrická energetická spoločnosť) became the first communal

producer of electricity in Slovakia. The other communal producers do not produce electricity. General reconstruction of the district heating system in Banská Bystrica is a typical example of conversion from thermal production to combined heat and power production.

Locality	Installed power capacity (MW_e)	Installed thermal capacity (MW_t)
Bratislava I.	14.4	136
Bratislava II.	20	438
Bratislava – West	25.0	262
Trnava	12.0	169
Martin	47.5	572
Banská Bystrica	5.85	50
Zvolen	34.8	176.2
Žilina	49.0	456
Nováky A	64.0	160
Nováky B	220.0	320
Košice	121.0	875.8
TOTAL	613.55	3 615

Table 4 Installed thermal and power capacity municipal heat power plants

2.3 Gas – steam cycles

Gas – steam cycles are generally divided into two groups:

a) Combustion turbine + boiler

Only one conventional gas – steam cycle is installed in Slovakia, in PPC Bratislava.

The parameters of this system are:

- installed power capacity: 218 MW_e (8^oC)
- installed thermal capacity: 186 MW_t

Gas steam cycle produces heat for the district heating system in Bratislava and covers basic consumption in DH system in Bratislava – West.

b) Combustion turbine + boiler + steam turbine

Prefixing of a combustion turbine in front of a heat boiler is a typical process of heat source reconstruction. This process provides increasing heat efficiency and is used in the Biotika Slovenská Ľupča company. The same reconstruction was done for the heat power plants in Žilina and Vojany II.

3. SHARE OF INSTALLED POWER CAPACITY FROM COGENERATION OF TOTAL INSTALLED POWER CAPACITY

The total installed power capacity is 8 321 MW_e in 2000. The estimation of the share of installed power capacity from cogeneration depends on the definition of cogeneration. Because there is no exactly definition of cogeneration in Slovakia, we use the same groups of combined heat and power production as in Chapter 5.2.

Installed capacity of cogeneration sources in shown in Table 5.

Type of cogeneration source	Installed power capacity (MW_e)
Small and medium gas – engine units	16.3
Heat and power plants	1 390.1
Of which: Industry sector	776.6
Municipality heat power plants	613.5
Gas steam cycles	218.0
Total	1 624.4

Table 5 Installed capacity of cogeneration sources

The share of individual types of cogeneration units of total installed power capacity is shown in Table 6. If we consider only small and medium gas-engine cogeneration units, installed power capacity makes up only 0.2% of the total installed power capacity in Slovakia. By adding small and medium gas–engine units and heat and power plants, the share is 17% and in the case of all types of combined heat and power generation sources, the share is 19.6% of total installed power capacity.

Type of cogeneration source	Total installed power capacity (MW_e)	Share of cogeneration on the electricity market (%)
Small and medium gas – engine units	16.3	0.2
Small and medium gas – engine units + heat and power plants	1 406.4	16.9
Small and medium units + heat and power plants + gas steam cycles	1 624.4	19.5

Table 6 Share of individual types of cogeneration units of total installed power capacity

The share of power produced by cogeneration is interesting from two criteria:

- power produced by cogeneration is higher than the share of installed sources, and has higher utilisation than installed sources

- power produced by cogeneration is higher than the average share of cogeneration in EU countries (9%)

Besides the share of production by cogeneration, the use factor of installed capacity is very important. Use Factor is defined as the share of annually electricity production to annually available capacity, which is 40.96% according to the data from the year 2000. The average for this factor is 43.2% in EU countries; Slovakia is at the same level as France and Ireland.

4. INDUSTRY SECTORS APPROPRIATE FOR IMPLEMENTATION OF CHP

One possibility for determining sectors where combined heat and power production could be a viable option is to examine the installed cogeneration units in Slovakia.

In the category of small and medium gas-engine cogeneration units (up to 5 MW_e), the first three places are the following:

by installed power capacity		by number of installed units	
1. municipality sector	(42.00%)	1. hospitals	(24.20%)
2. hospitals	(14.80%)	2. residential sector	(21.17%)
3. administration buildings	(14.08%)	3. industry	(17.14%)

In the category of conventional heat and power plants in the industry sector, the first three places are following:

by installed power capacity		by number of installed unit	
1. metallurgical	(30.00%)	1. textile	(18.00%)
2. chemical	(18.00%)	2. chemical	(17.00%)
3. malt & paper	(16.00%)	3. mechanical industry	(13.00%)

4.1. Industrial energy sector

Utilisation of CHP units sector is high in industrial energy. The electricity produced is used for own consumption. Because industrial complexes are generally consumers of electric power in composite tariffs, use of cogeneration enabled a decrease of electricity taken from the net, as well as a decrease of settled and measured maximums. First of all in combination with other measures (control of maximums) the cogeneration units provide considerable savings in the field of energy consumption.

Heat utilisation is the basic condition for effective cogeneration unit operation in industrial companies. In addition to the possibilities for using heat for heating and HDW preparation, heat is used for the heat demands of technology. Cogeneration units with higher installed capacity (from several 100 kW of capacity) can also produce steam. Of course, it is possible to produce cooling in combination with absorption cooler.

4.2. Communal and tertiary sector

In addition, conventional heat and power plants are installed in industries with high consumption of electricity and power (metallurgical industry, chemical, textile, mechanical industry, etc.) The communal and tertiary sector is the best for installation.

Communal boilers (Heating of buildings)

Heat and HDW supply in buildings is one of the most promising development fields for combined production in Slovakia. First of all, this is an opportunity for central heat supply systems. Concerning the annual heat production for HDW preparation, cogeneration units achieve high yearly utilisation.

Cogeneration units can be used in communal plants in several ways:

1. Cogeneration units are used for heat consumption with maximal yearly utilisation (generally production of HDW) and where electricity is partly consumed in the boiler room; the rest is delivered to the power network.
2. Minimal variant of cogeneration units utilisation, used in objects with low energy consumption (as communal boiler rooms), is to cover own boiler room consumption, and heat produced will be used in own central heat supply system.
3. Another possibility is electric power production at times of net peak load, for sale in the power network with utilisation of heat produced in own central heat supply system.

Hospitals

Hospitals are also a sector where it is possible to use CHP as a heat and electricity source. First of all, thanks to yearly heat demand of HDW it is possible to reach high yearly operational utilisation of cogeneration units. The electricity is used for own consumption.

Cogeneration units can work also in an independent operation (without connection to a distribution network), which enables this unit be used as a back-up electricity power supply. In

this case, it is possible to use also double-fuel cogeneration units (in addition to natural gas also e.g. diesel oil) to implement the principle of an independent fuel base.

Hotels

In hotels, CHP units are designed for internal consumption of HDW and electricity. There is also the possibility to use the heat in air-conditioning, in conjunction with absorption cooler. Cogeneration units often enable a change of tariffs. A hotel with cogeneration is able to produce a large part of the electricity by itself; therefore it can change from two-component tariffs (payment separately for use and separately for operation to single-component tariffs (payment only for use).

The ability of cogeneration units to work as an alternative source of electric power is important in the case of hotels. Failures of electric power mainly in mountain areas make inconveniences for guests in the hotel and causes financial losses for the hotels.

Swimming pools

Swimming pools belong among the most advantageous operations for using combined production. Yearly and relatively stable heat demand for the heating of swimming water and HDW enable them to reach a high level of utility through cogeneration. A correctly designed cogeneration unit can work full power nearly non-stop in swimming pools. Thereby maximum operation efficiency can be achieved.
Produced electricity is used to cover internal consumption of the object, which is, depending upon the installed technology, relatively stable. Only small surpluses are delivered to the electric power net. Also in this case savings could be improved by exchange of two-component tariffs with a single-component.

Family houses

The use of cogeneration units in houses is in the initial phase in Slovakia. However, CHP units are used in houses; this is mainly in the case of a house built in an area where the energy distributor company can not guarantee the required power of the project. In this case cogeneration is a cheaper solution and could cover electric power demands of the house. For system reliability of heat consumption, it is also necessary to provide heat and the ideal solution is a heated basin.

Agriculture and Waste Water Treatment Plants (WWTP)

Biogas is the most interesting alternative for use as a fuel for cogeneration units. The quality of biogas is very important. Undesirable substances could cause failures in motors and decrease operational safety. Cogeneration units achieve high savings because of the quality of biogas.

The heat produced is used for heating of HDW, space heating and in technology for biogas production. Electric power is used directly in the operation, and surpluses are delivered into the electric power net.

5. POTENTIAL OF CHP IN THE SLOVAK REPUBLIC

Two aspects of CHP have been estimated: the technical and economical potential. The technical potential assumes the implementation of all technically feasible CHP options. The economic potential considers the economic viability of CHP projects. It should be noted that these potentials strongly depend on estimates, and should be regarded as indicative only. Medium scale and small scale cogeneration is considered.

5.1. Technical potential

It is limited mainly by demand for heat and the availability of distribution systems. The total technical potential for new capacity in 2010 is estimated at 1 480 MW_e; this corresponds to an increase of 150% of currently installed capacity.

	Capacity range (MW_e)	Power (MW_e)	Heat (MW_t)	Heat/Power ratio
Medium-scale-industry	5-50	180	250	1.4
Medium-scale-DH	5-50	200	280	1.4
Small-scale	to 5	1 100	1 870	1.7
Total	-	1 480	2 400	1.6

Table 7 Estimated technical potential of CHP in the Slovak Republic in 2010 [2]

The major application of CHP within the three categories is the following. All options include the use of fossil fuels (coal, natural gas, oil) and renewable energy sources (wood, straw, and biogas):

Medium-scale CHP plants in industry include usually the replacement of old boilers by new CHP units, in many cases including a switch from coal to gas, rehabilitation/replacement of existing steam turbine and/or installation of new steam turbines in former boiler plants.

Medium-scale CHP plants in district heating include a large variety of CHP plants: CHP plants with backpressure steam turbines, combine-cycle CHP plants and gas engines.

Small-scale CHP plants include many new projects with gas engines in municipal district boiler plants, in sewage treatment plants, and in commercial services.

5.2. Economic potential

Due to major economic barriers for CHP implementation, it is more realistic to use the economic potential for setting implementation targets. It is influenced by a range of economic assumptions like pay-back period of investments and viability of technologies based on macro economy. The economic potential is 565 MW_e in 2010 corresponding to approximately one third of the technical potential. See Table 8 for a breakdown of this potential.

	Capacity range (MW_e)	(MW_e)	(MW_t)	Economical/ technical potential (%)
Medium-scale-Industry	5-50	120	180	67
Medium-scale-DH	5-50	125	200	63
Small-scale	to 5	320	500	29
Total	-	565	880	38

Table 8 Economical potential for small and medium-scale CHP in Slovakia till 2010

The conclusion can be drawn that in addition to the existing share of CHP, a large technical potential still remains in the Slovak Republic. The economic potential strongly depends on economic conditions, but with slightly more favourable conditions than at present the economic potential to the year 2010 still represents a large potential growth.

5.3. Market potential

Market potential was assessed based on micro economy taking into account the investor's view point on financial viability of investments, i.e. real pay-back period, real interest rate, inflation and technology risks.

Since the economy viability of CHP has a pay-back period close to accepted by market actors, there have been considered only additional limitation of technology penetration i.e. risks, financial capacity, low awareness on technology advantages. Market potential is presented in the Table 9.

	Capacity range (MW_e)	(MW_e)	(MW_t)
Medium-scale-Industry	5-50	108	162
Medium-scale-DH	5-50	100	160
Small-scale	to 5	240	375
Total	-	448	697

Table 9 Market potential for small and medium-scale CHP in Slovakia till 2010

6. BARRIERS AND INSTRUMENTS OF MARKET DEVELOPMENT

Barriers for combined heat and power in Slovakia can be summarised as follows:

6.1. Lack of policy and institutional framework

A policy framework to promote CHP, with CHP targets and priorities, is to a large extent lacking. In energy policy CHP has a low priority. Furthermore, the present co-operation between the various stakeholders and the Government in the promotion of CHP is rather weak. A strong institutional framework for CHP is required as a solid common basis for improving energy efficiency in the Slovak Republic.

6.2. Regulatory framework

Legally, free access to the grid for independent producers exists. In practice inadequate payment for sales of surplus capacity to the grid and high tariffs for stand-by and top-up supplies offered by the distribution companies, who are natural monopolies and make use of this position, exclude the CHP alternative. These are the factors impeding the penetration of CHP even in a partly liberalised European energy market.

6.3. Pricing and tariffs

Major economic barriers in the generation and sale of electricity and heat arise from the distorted prices. Distortions originate in the policy of social acceptance of energy costs for households - industry pays a higher than cost-based price for electricity and gas, while households benefit from cross subsidies. The process of removing the subsidies has been started and should be terminated in a short time.

6.4. Lack of knowledge and awareness

Many potential users and possible investors are not aware of the advantages of CHP, in particular of small-scale CHP. The need for external qualified assistance is underestimated as well as the necessity of proper project development and its relevant costs, despite the fact that lack of experience can lead to large overhead costs for the development of small CHP projects, with risk of project failure. In the energy policy of the Slovak Republic, the support of CHP implementation has been declared as one of the short- and medium-term goals.

6.5. Technical conditions of distribution companies for connecting of cogeneration units to the electricity network

Standards of the distribution companies (ZSE, VSE, and SSE) are so strict that total competition needs higher investment than investment for cogeneration. Reduction of connection standards is possible only after long and complicated interviews with these companies. The reasons are: concerns over security and insufficient knowledge. This barrier is removable only in time, possible instruments are: seminars, workshops, demonstration projects, visits, etc…

6.6. Purchase price of electricity by cogeneration – non-favourable price of electricity purchase in peak tariff

In the Slovak heat market favourable pricing of electricity purchase in peak tariff does not exist. This situation is very important for the development of cogeneration in the heat market. For example, the purchase of electricity is strongly supported in peak time in the Czech Republic. Cogeneration units with high installed performance are in process only in peak times and the heat produced is accumulated and consumed as needed

6.7. Instability of tax conditions

Tax conditions are not stable in Slovakia, especially the issue of tax holidays. This aspect was often changed in the time period of two years and there are lot of changes in the process.
Other measures:

7. AUDITS FOR CHP PLANTS

It is suggested to offer direct financial support for audits of boiler houses to be constructed or retrofitted. These audits should systematically examine the opportunity of installing small CHP installations. This measure should address installations with a total heat output under 5 MW. The audit should be part of the application for public support.

8. CLEARING HOUSE FOR CHP PROJECTS

Although the potential for CHP is rather high in Slovakia (1,200 to 1,500 MWel), it is only developed to a limited extent. National and international funding exist, through direct support programmes, ESCOs, grants and loans, but they are not well know by potential beneficiaries or their criteria do not fit with the funding schemes requirements. It is therefore proposed to strengthen the clearing house operated by the Slovak Energy Agency in order to identify a pipeline of projects and assist beneficiaries in submitting applications to donors. Having an overview of the sector, the unit can also propose bundling of projects as a solution for small scale plants that would not otherwise be eligible.